IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	10/628,181
Appellant	:	Min-Yi Shih and Thomas B. Gorczcya
Filed	:	25 July 2003
Title	:	INDEX CONTRAST ENHANCED OPTICAL WAVEGUIDES AND FABRICATION METHODS
TC/A.U.	:	1791
Examiner	:	Mathieu D. Vargot
Docket No.	:	134404-1
Confirmation No.		5586
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Commissioner for Patents
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APPEAL BRIEF PURSUANT TO 37 C.F.R. § 41.37

This Appeal Brief is being filed in furtherance to the Notice of Appeal electronically submitted on 20 November 2007.

The Commissioner is authorized to charge the requisite fee of $510.00, and any additional fees which may be necessary to advance prosecution of the present application, to Account No. 07-0868.

1. REAL PARTY IN INTEREST

The real party in interest is General Electric Company, the Assignee of the above-referenced application by virtue of the Assignment to General Electric Company by Min-Yi Shih and Thomas B. Gorczcya. Accordingly, General Electric Company will be directly affected by the Board's decision in the pending appeal.

2. RELATED APPEALS AND INTERFERENCES

Appellant is unaware of any other appeals or interferences related to this Appeal. The undersigned is Appellant's legal representative in this Appeal.

3. STATUS OF CLAIMS

Claims 1-8, 10-11, and 13-32 are currently pending, are currently under final rejection and, thus, are the subject of this Appeal.

4. STATUS OF AMENDMENTS

There are no outstanding amendments to be considered by the Board.

5. SUMMARY OF CLAIMED SUBJECT MATTER

The present invention relates generally to the field of optical waveguides and more particularly to methods of forming optical waveguides (Paragraphs 1 and 8-10).

The Application includes two independent claims, claims 1 and 16, both of which are the subject of this Appeal. The subject matter of these claims is summarized below.

Claim 1 recites a method of forming a waveguide comprising a core region 12, a cladding region 14, and an index contrast region 16 situated therebetween (FIG. 5, Paragraph 39). A polymerizable composite comprising a polymer binder and an uncured monomer is deposited on a substrate 20 to form a layer 22 (FIG. 7, Paragraph 42). The layer is patterned to define an exposed area 26 and an unexposed area 28 in a manner such that the unexposed area 28 includes the core region (FIG. 7, Paragraphs 41-42). The exposed area 26 of the layer 22 is irradiated to polymerize the polymerizable composite in the exposed area (FIG. 7, Paragraphs 42 and 50). The uncured monomer is volatilized in the unexposed area 28 by baking and by diffusing some uncured monomer from the unexposed area towards the exposed area to form the index contrast region of the waveguide (FIGs. 8-9, Paragraphs 42 and 46).

Claim 16 recites a different method of forming a waveguide comprising a core region 12, a cladding region 14, and an index contrast region 16 situated therebetween (FIG. 14, Paragraph 60). The composite is provided, deposited to form layer 22, and irradiated in a similar manner as with claim 1 (FIGs. 7-8, paragraph 60). The patterning is different in that one portion of the unexposed area comprises the core region 12 and another portion of the unexposed area comprises a diffusion source region 32, 532 (FIG. 14, Paragraph 60). Then, during the volatilizing, the uncured monomer is volatilized both in the core and diffusion source regions 12 and 32, 532 to diffuse some uncured monomer from the unexposed area towards the exposed area and form the index contrast region 16 of the waveguide (FIGs. 14-16, Paragraphs 60-61).

The described methods are expected to provide waveguide structures with reduced losses and the potential for tighter bends (Paragraphs 7 and 58).

6. <u>GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL</u>

Appellant respectfully urges the Board to review and reverse the Examiner's ground of rejection in which claims 1-8, 10-11, and 13-32 were rejected under 35 USC 103(a) over Suzuki US4877717 or Chandross US3809732 in view of Nishimura US6828078.

7. <u>ARGUMENT</u>

Appellant respectfully submits that the Examiner has improperly rejected the pending claims and believes that claims 1-8, 10-11, and 13-32 are currently in condition for allowance. Accordingly, Appellant respectfully requests full and favorable consideration by the Board.

A. <u>Ground of Rejection</u>

The Examiner rejected claims 1-8, 10-11, and 13-32 under 35 USC 103(a) over Suzuki or Chandross in view of Nishimura.

1. <u>Legal basis required to establish a *prima facie* case of obviousness.</u>

In addressing obviousness determinations under 35 USC 103, the Supreme Court in *KSR International Co. v. Teleflex Inc.*, No. 04-1350 (April 30, 2007), reaffirmed many of its precedents relating to obviousness including its holding in *Graham v. John Deere Co.,* 383 U.S. 1 (1966). In *KSR*, the Court also reaffirmed that "a patent composed of several elements is not proved obvious merely by demonstrating that each of its elements was, independently, known in

the prior art." *Id.* at 14. In this regard, the *KSR* court stated that "it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does … because inventions in most, if not all, instances rely upon building blocks long since uncovered, and claimed discoveries almost of necessity will be combinations of what, in some sense, is already known." *Id.* at 14-15. Furthermore, the *KSR* court did not diminish the requirement for objective evidence of obviousness. *Id.* at 14 ("To facilitate review, this analysis should be made explicit. See *In re Kahn,* 441 F.3d 977, 988 (CA Fed. 2006) ("[R]ejections on obviousness grounds cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness").

2. The Examiner's rejection of independent claim 1 is improper because the rejection fails to establish a *prima facie* case of obviousness.

Chandross exposes the area to form the core as can be seen from FIGs. 2C and 2D and from column 2 lines 48-56 (which discuss using the exposure to lock in the dopant); column 2, lines 56-60 (which reference then removing the dopant from the unexposed areas); and column 4, lines 28-33 (which reference writing of an optical circuit pattern using a focused beam of radiation).

Chandross does not disclose "volatilizing the uncured monomer in the unexposed area by baking and by diffusing some uncured monomer from the unexposed area towards the exposed area to form the index contrast region of the waveguide". In Chandross, the structure is heated to evaporate unexposed dopant, and neither diffusion nor an index contrast region appear to be addressed as can be seen from, for example, column 5, lines 42-52:

> The final step in the flow chart of FIG. 1 involves the development of the exposed circuit pattern in film 22. Development is carried out by simple heating of the film to evaporate the unexposed portion of the dopant. This step leaves the exposed portions of the dopant in position in the film and has two consequences: first, the refractive index of the exposed portions of film 22 is intermediate between that of the original poly and that of the dopant material itself; and, secondly, the thickness of film 22 is reduced in the unexposed regions thereof due to removal of the unexposed dopant. A structure of the type illustrated in FIG. 2D of the drawing results.

With respect to Suzuki, Appellant respectfully submits that Suzuki does not teach or disclose the claim 1 recitations that are discussed above in with respect to Chandross. Like Chandross, Suzuki exposes the area to form the core. This is most easily seen in Suzuki FIG. 24 and column 18, lines 33 through 49, as well as column 7, line 58.

Suzuki also does not appear to describe volatizing by baking and diffusing. Suzuki

column 18, lines 16-59 state:

> The above-described formation of the optical elements will be further described with reference to FIGS. 20A and 20B. A light-sensitive film 52 is positioned on the substrate 51 and consists of photo-reactive compounds M, compounds N capable of being absorbed by the reaction products P of the compounds M (compounds N may be the same or different from the compounds M), and binding polymers BP. ….
>
> As illustrated in FIG. 20A selective exposure of the film 52 is carried out through a photomask 53. During this exposure, reaction products P of the compounds M are produced in the exposed area 55. These reaction products P absorb the compounds M and/or N contained in the exposed area and swell. Then, the absorbed compounds M further produce reaction products P. These new reaction products P absorb the compounds M and/or N diffused from the unexposed area 56 and swell. The exposed area 55 containing the reaction products P therefore continues to swell, so long as the compounds M and/or N are supplied to that area. FIG. 20B shows the results of the formation process according to the described embodiment. Type of gradient thickness films which are possible include a diffraction grating, as illustrated in FIG. 23, and an optical waveguide, as illustrated in FIG. 24.
>
> According to the present invention, a large variation in the form of the light-sensitive film can be obtained because the expansion of the exposed area of the film is induced by the irradiation of radiation. Further, if an outer force such as gravity does not affect the system, the expansion of the exposed area will be continued until the photoreactive compounds in the film are exhausted. Accordingly, optical elements such as gradient thickness films having a remarkably varied film form can be obtained.

Although some polymerization is indicated to continue to occur after the irradiation, no combination of baking and diffusing is described.

With respect to Nishimura, Nishimura describes generation of a “low RI (reactive index)” area by locally generating (by photo patterning) an acid which decomposes the high RI component (A) which then must be removed from the system by volatilization. The decomposition only reduces the molecular weight of the high RI component so it can volatilize - the decomposition does not change the RI. Once volatilized, the region has less of the high RI component-A and therefore a lower RI. Decomposition itself does not change the RI of component-A or the region. The RI only decreases when component-A is removed. The degree of decomposition of component-A and resulting amount volatilized (and subsequent change in RI) probably is effected by the amount of photoacid present, and the photoacid may be able to move around (or diffuse) a bit, but decomposition/volatilization of component-A is what causes the RI change. Uncured monomers are not described or present in Nishimura’s patent, and no diffusion is described as forming index contrast areas.

The Examiner stated in the Advisory Action:

> Nishimura is being relied upon simply to teach one of ordinary skill in the art that an unexposed area can include--ie, become--the core, and that is how Nishimura is modifying the method of the primary references. Indeed, the primary references teach the basic claimed method, albeit that the exposed area becomes the core rather than the unexposed area becoming the core.

However, Appellant submits that, in Suzuki and Chandross, the monomers are high

refractive index (RI) components, and the exposed areas form the core. In contrast, in Nishimura, the core is formed in the unexposed areas but by a different mechanism: decomposing high RI polymers by exposure (which leads to evaporation). It is not clear to Appellant the reason why it would be obvious for one to combine teachings from the embodiment of Nishimura regarding the decomposition of high RI polymer with the teachings of Suzuki and Chandross and their high RI monomers to arrive at Appellant's claimed embodiments.

Accordingly, Appellant respectfully submits that claim 1 and claims 2-8, 10-11, and 13-15 which depend therefrom define allowable subject matter over the applied references.

3. <u>The Examiner's rejection of independent claim 16 is improper because the rejection fails to establish a *prima facie* case of obviousness.</u>

With respect to the "diffusion source regions" of claim 16, Appellant respectfully directs the Examiner's attention to FIGs. 14-19 which are described in paragraphs 60-65 with paragraph 60 and FIG. 14 being copied below for ease of reference (with emphasis):

> [0060] FIG. 14 is a top view of a curved waveguide **10** core **12** and cladding **14** including index contrast regions in accordance with another embodiment of the present invention. The embodiment of FIG. 14 is designed for enhancing the amount of monomer diffusion into selected catalyst activated (exposed) areas by providing additional monomer diffusion source regions near one or both sides of a bend radius. In the embodiment of FIG. 14 <u>one source of monomer diffusion is from core **12** itself and a second source of monomer diffusion **32**</u> is from an unexposed region adjacent to the side cladding surrounding the core. Both sources can be fabricated simultaneously by a masking process, for example.

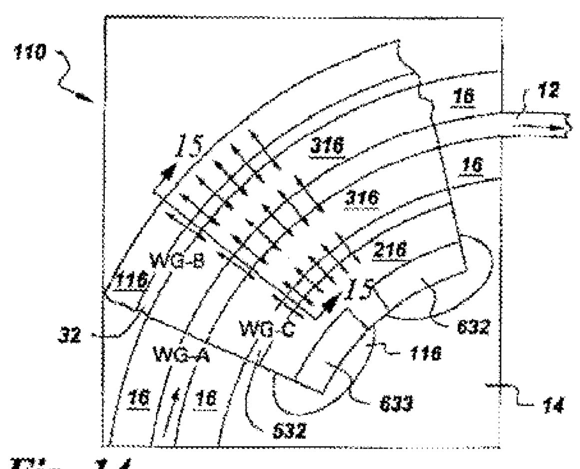

Fig. 14

Diffusion source regions are described in claim 16 as being patterned in combination with the core region and are not the core regions themselves (see claim 16 for example: one portion of the unexposed area comprising the core region **<u>and another portion</u>** of the unexposed area

comprising a diffusion source region).

In other words, Appellant has described and claimed diffusion source regions that are a third region in addition to the unexposed core regions and the exposed bulk regions. Appellant can find no such regions either taught or suggested in any of the applied references, whether taken individually or in combination. Nishimura does not teach or suggest such additional regions *(nor would it be possible in Nishimura's case because the clad is formed by decomposition and subsequent evaporation of high RI components, not diffusion/polymerization of low RI components as in the present Application)* and, because Chandross and Suzuki form the core by the exposed area, such additional diffusion source regions would not be feasible with those embodiments.

Appellant reiterates herein that, as stated above in Appellant's remarks, the diffusion source regions of claim 16 are a separate part of the pattern, and no such regions are taught or suggested by any reference or combination of references.

The third region (the diffusion source region) recited by Appellant cannot be provided by Nishimura. Because Nishimura decomposes high RI components in the exposed area which evaporate leaving the area with lower RI, no polymerization occurs. This third region is also not feasible in Suzuki or Chandross because polymerization does not take place in the cladding.

No combination of the applied references polymerizes monomers in the cladding (low RI) portion, and thus no combination can effect RI in said portion by controlling the amount of diffusion/polymerization into the exposed cladding by supplying the additional third (unexposed) region.

In response to the above arguments, the Examiner stated in the Advisory Action (with emphasis added):

> Concerning instant claims 11 and 16, it is submitted that this matter was indeed addressed. As noted in the rejection, **the diffusion that is clearly occurring in the primary references would require that some portion of the unexposed area be a "diffusion source region", regardless of whether the references explicitly call it such**. In this case, the diffusion source region would be part of the unexposed clad in the primary references--however, one of ordinary skill in the art, using the teaching of exposing the cladding area in Nishimura, would understand that the diffusion source region would come from the unexposed core area. Simply because applicant has used terms that are not explicitly found in the references does not mean that a diffusion source region is in fact not there in the primary references. While it would not be part of the unexposed core, it would be part of the unexposed clad in the primary references. Again, the aspect of exposing the clad is taught in Nishimura. The instant claims do not require a "third" portion that is any different from that that is unexposed, other than specifying that the unexposed area includes a core region and another portion that is the diffusion source region. The method of the primary references would have exactly these portions, albeit they would be in the cladding portion. However, the combination with Nishimura would render them being in the core portion obvious.

Appellant respectfully submits that, in both Chandross and Suzuki, the core area is exposed, polymerizing the high RI monomers in that area, while in the unexposed area they either evaporate or diffuse into the core region. In both cases, it is not possible to get enhanced index contrast in the clad area with respect to the exposed core region because there is no control in the clad areas on its final composition, which (in the end) consists of the original polymer binder with all high RI monomers removed. In the embodiment of Appellant's claim 16, the cladding is exposed and its final composition depends on the amount of low RI monomers that diffuse into it from both the core region and additional unexposed regions in the cladding, which can be controlled (Fig. 14 above). The core region, in the embodiment of Appellant's claim 16, consists (in the end) of the original high RI polymer binder with all the low RI monomers removed.

Nishimura's case of exposed cladding (which activates an acid-catalyst decomposition of the high RI components) does not make the present claim of exposed cladding (which activates a catalyst polymerization of low RI components) with an additional area of unexposed cladding to provide additional monomer for diffusion into the exposed areas to enable enhanced index contrast, obvious. Nishimura's method can not be used to enhance index contrast between core and clad, and in fact, does just the opposite. Any acid-catalyst diffusion from the exposed cladding area into the core results in decomposition of high RI components in the core, resulting in lower index contrast. Likewise, any diffusion of high RI components from the core to the cladding (which may occur due to the concentration gradient present) would result in the core area with less (high RI) material, again, lowering its RI with respect to the clad.

Any combination of the primary references does not make the claim 16 recitations obvious because the chemistry, materials, and methods used to form the core and clad areas differ. Again, Appellant has described and claimed the only embodiment which polymerizes low RI monomers in the cladding areas, and because of this, the only method which can be used to form enhanced index contrast in the cladding areas by supplying additional unexposed areas of clad for monomer diffusion.

Accordingly, Appellant respectfully submits that claim 16 and claims 17-32 which depend therefrom define allowable subject matter over the applied references.

Conclusion

Appellant respectfully submits that all pending claims are in condition for allowance. However, if the Examiner or Board wishes to resolve any other issues by way of a telephone conference, the Examiner or Board is kindly invited to contact the undersigned attorney at the telephone number indicated below.

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8. APPENDIX OF CLAIMS ON APPEAL

Listing of Claims:

1. A method of forming a waveguide comprising a core region, a cladding region, and an index contrast region situated therebetween, the method comprising:

depositing a polymerizable composite on a substrate to form a layer, wherein the polymerizable composite comprises a polymer binder and an uncured monomer,

patterning the layer to define an exposed area and an unexposed area of the layer in a manner such that the unexposed area includes the core region,

irradiating the exposed area of the layer to polymerize the polymerizable composite in the exposed area, and

volatilizing the uncured monomer in the unexposed area by baking and by diffusing some uncured monomer from the unexposed area towards the exposed area to form the index contrast region of the waveguide.

2. The method of claim 1, wherein the polymer binder comprises at least one of an acrylate polymer, a polyester, a polyimide, a polycarbonate, a polysulfone, a polyether ketone, and combinations thereof.

3. The method of claim 1, wherein the polymer binder comprises an acrylate polymer comprising at least one of a poly(methyl methacrylate), poly(tetrafluoropropyl methacrylate), poly(2,2,2-triflouroethyl methacrylate), copolymers comprising structural units derived from an acrylate polymer, and combinations thereof.

4. The method of claim 1, wherein the uncured monomer comprises at least one of an acrylic monomer, a cyanate monomer, a vinyl monomer, an epoxide-containing monomer, and combinations thereof.

5. The method of claim 1, wherein the uncured monomer comprises at least one of benzyl methacrylate, 2,2,2-trifluoroethyl methacrylate, tetrafluoropropyl methacrylate, methyl methacrylate, 3-4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate, bisphenol A diglycidyl ether, bisphenol F diglycidyl ether, styrene, allyl diglycol carbonate, and cyanate ester.

6. The method of claim 1, wherein irradiating the exposed area of the layer comprises irradiating the exposed area with ultraviolet radiation.

7. The method of claim 1, wherein patterning the layer comprises patterning the layer using a gray scale mask.

8. The method of claim 1 wherein patterning comprises patterning the layer to define at least one curve.

10. The method of claim 9 wherein the polymerizable composite comprises a polysulfone/epoxy blend.

11. The method of claim 9 wherein patterning is performed in a manner such that the unexposed area further includes a diffusion source region.

13. The method of claim 11 wherein the polymerizable composite comprises an acrylic/epoxy blend.

14. The method of claim 13 wherein polymerizable composite includes a concentration of at least about 25% uncured monomer.

15. The method of claim 13 wherein polymerizable composite includes a concentration of at least about 40% uncured monomer.

16. A method of forming a waveguide comprising a core region, a cladding region, and an index contrast region situated therebetween, the method comprising:

providing a polymerizable composite comprising a polymer binder and an uncured monomer,

depositing the polymerizable composite on a substrate to form a layer,

patterning the layer to define an exposed area and an unexposed area of the layer, one portion of the unexposed area comprising the core region and another portion of the unexposed area comprising a diffusion source region,

irradiating the exposed area of the layer to polymerize the polymerizable composite in the exposed area, and

volatilizing the uncured monomer in the core and diffusion source regions to diffuse some uncured monomer from the unexposed area towards the exposed area and form the index contrast region of the waveguide.

17. The method of claim 16, wherein the polymer binder comprises at least one of an acrylate polymer, a polyester, a polyimide, a polycarbonate, a polysulfone, a polyether ketone, and combinations thereof.

18. The method of claim 16, wherein the polymer binder comprises an acrylate polymer comprising at least one of a poly(methyl methacrylate), poly(tetrafluoropropyl methacrylate), poly(2,2,2-triflouroethyl methacrylate), copolymers comprising structural units derived from an acrylate polymer, and combinations thereof.

19. The method of claim 16, wherein the uncured monomer comprises at least one of an acrylic monomer, a cyanate monomer, a vinyl monomer, an epoxide-containing monomer, and combinations thereof.

20. The method of claim 16, wherein the uncured monomer comprises at least one of benzyl methacrylate, 2,2,2-trifluoroethyl methacrylate, tetrafluoropropyl methacrylate, methyl methacrylate, 3-4-epoxycyclohexylmethyl-3,4-epoxycyclohexane carboxylate, bisphenol A diglycidyl ether, bisphenol F diglycidyl ether, styrene, allyl diglycol carbonate, and cyanate ester.

21. The method of claim 16, wherein irradiating the exposed area of the layer comprises irradiating the exposed area with ultraviolet radiation.

22. The method of claim 16, wherein patterning the layer comprises patterning the layer using a gray scale mask.

23. The method of claim 16, wherein patterning comprises defining the diffusion source region adjacent to the index contrast region.

24. The method of claim 23 wherein at least one end portion of the diffusion source region is situated further from the core region than a center portion of the diffusion source region.

25. The method of claim 24 wherein the diffusion source region is patterned to form an adiabatic mode-converter.

26. The method of claim 16, wherein the diffusion source region comprises at least two diffusion source regions.

27. The method of claim 26, wherein the at least two diffusion source regions include diffusion source regions situated on opposing sides of the core region.

28. The method of claim 27, wherein the at least two diffusion source regions further include multiple diffusion source regions situated on one side of the core region.

29. The method of claim 26, wherein the at least two diffusion source regions include multiple diffusion source regions situated on one side of the core region.

30. The method of claim 29, wherein the multiple diffusion source regions are each adjacent to the index contrast region.

31. The method of claim 29, wherein at least one of the multiple diffusion source regions is situated between the core region and at least one other of the multiple diffusion source regions.

32. The method of claim 26, wherein the at least two diffusion source regions comprise at least one device selected from the group consisting of Omni reflectors, Bragg gratings, directional couplers, and combinations thereof.

9. APPENDIX OF EVIDENCE

None.

10. APPENDIX OF RELATED PROCEEDINGS

None.